Town Creek Marsh System: Hydrodynamic Analysis

WOODS HOLE GROUP

SALISBURY MASSACHUSETTS 1638

July 25, 2011

Project Background

1. Embankment breached in April 2007 (Patriot's Day Storm)

2. Bikeway construction (Rail-trail)

3. Embankment Rehabilitation

4. DER opportunity for habitat restoration and flood mitigation

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Project Components

1. Construction of Rail-trail
   - Fay, Spofford, and Thorndike

2. Repair of embankment
   - PARE Corporation
   - Town of Salisbury

3. Hydrodynamic Assessment
   - Woods Hole Group
   - Division of Ecological Restoration

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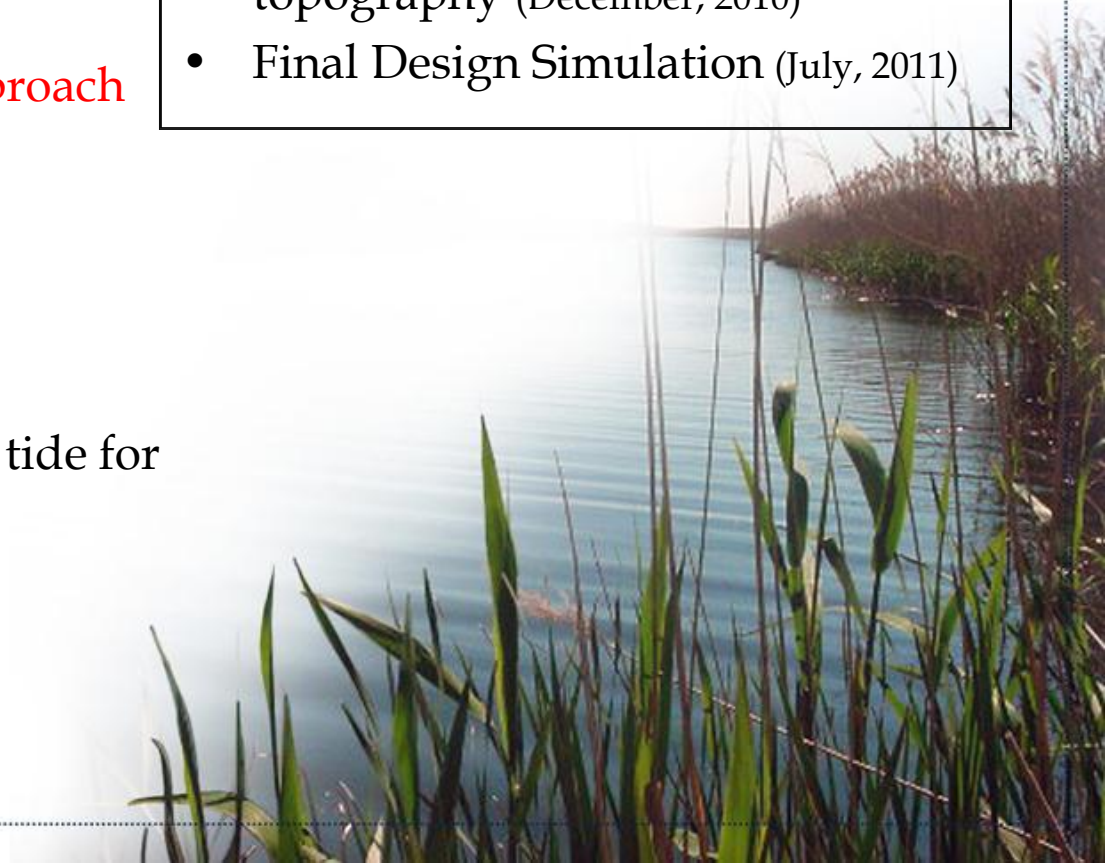
Hydrodynamic Project Goals

1. Habitat Restoration
   - Improved tidal exchange
   - Increased salinity levels
   - Improved water quality
   - Improved fish passage
   - Adaptive Management Approach

2. Flood Mitigation
   - Improved drainage
   - Ability to limit high tides
   - Ability to close gates at low tide for additional flood storage

Hydrodynamic Analysis

- Evaluation of second culvert (July, 2008)
- Updated and improved topography (December, 2010)
- Final Design Simulation (July, 2011)



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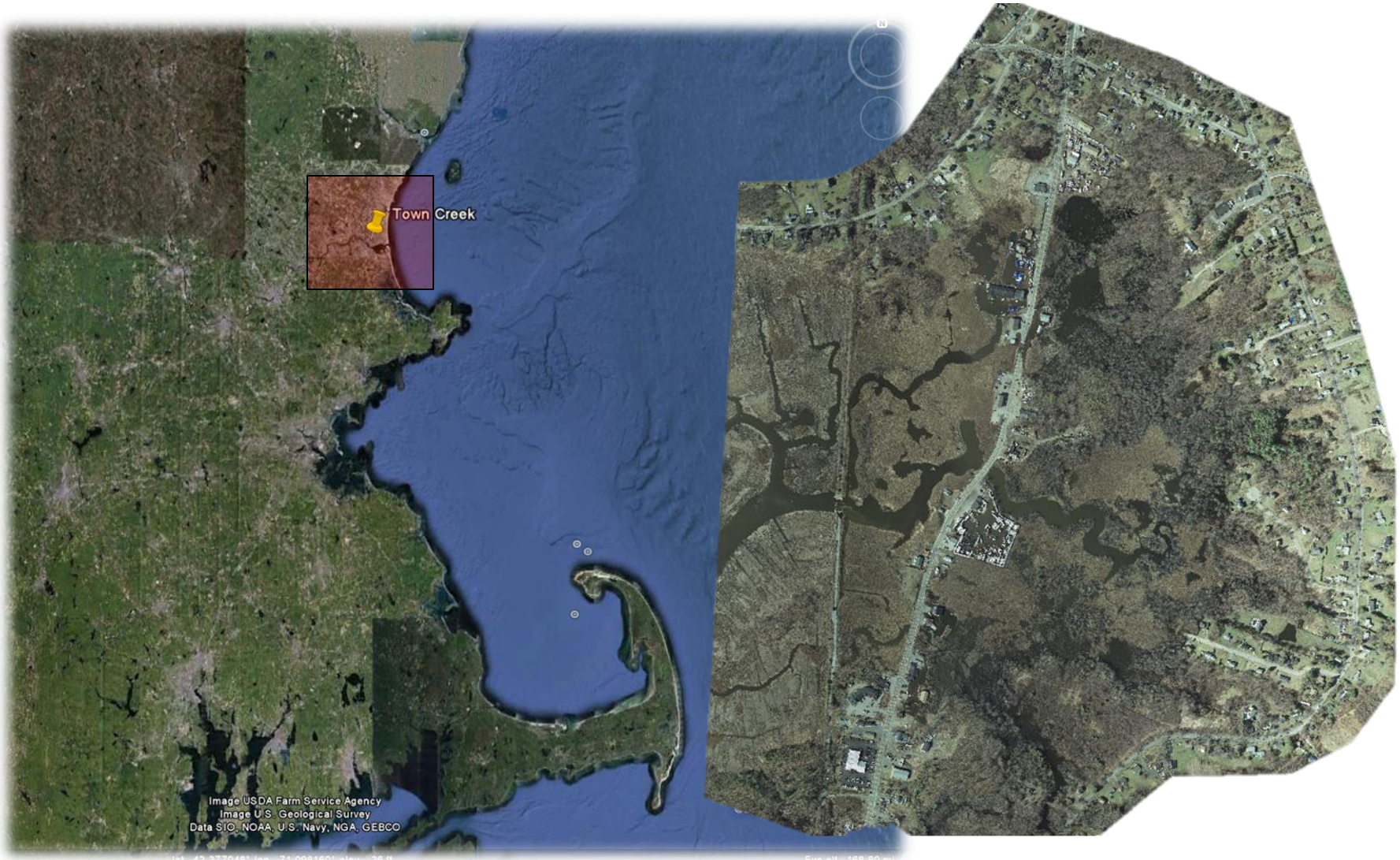
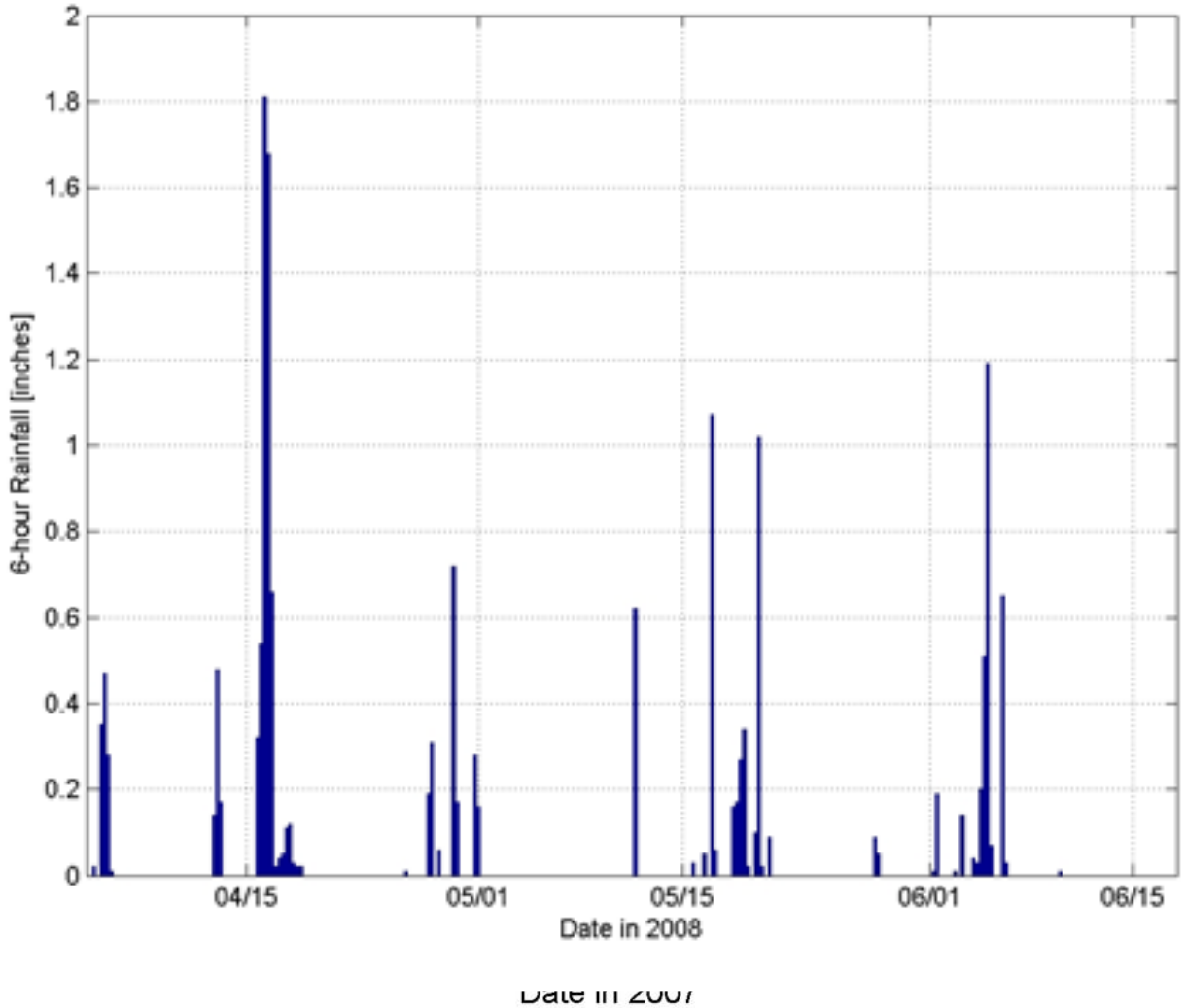
Town Creek Estuary System

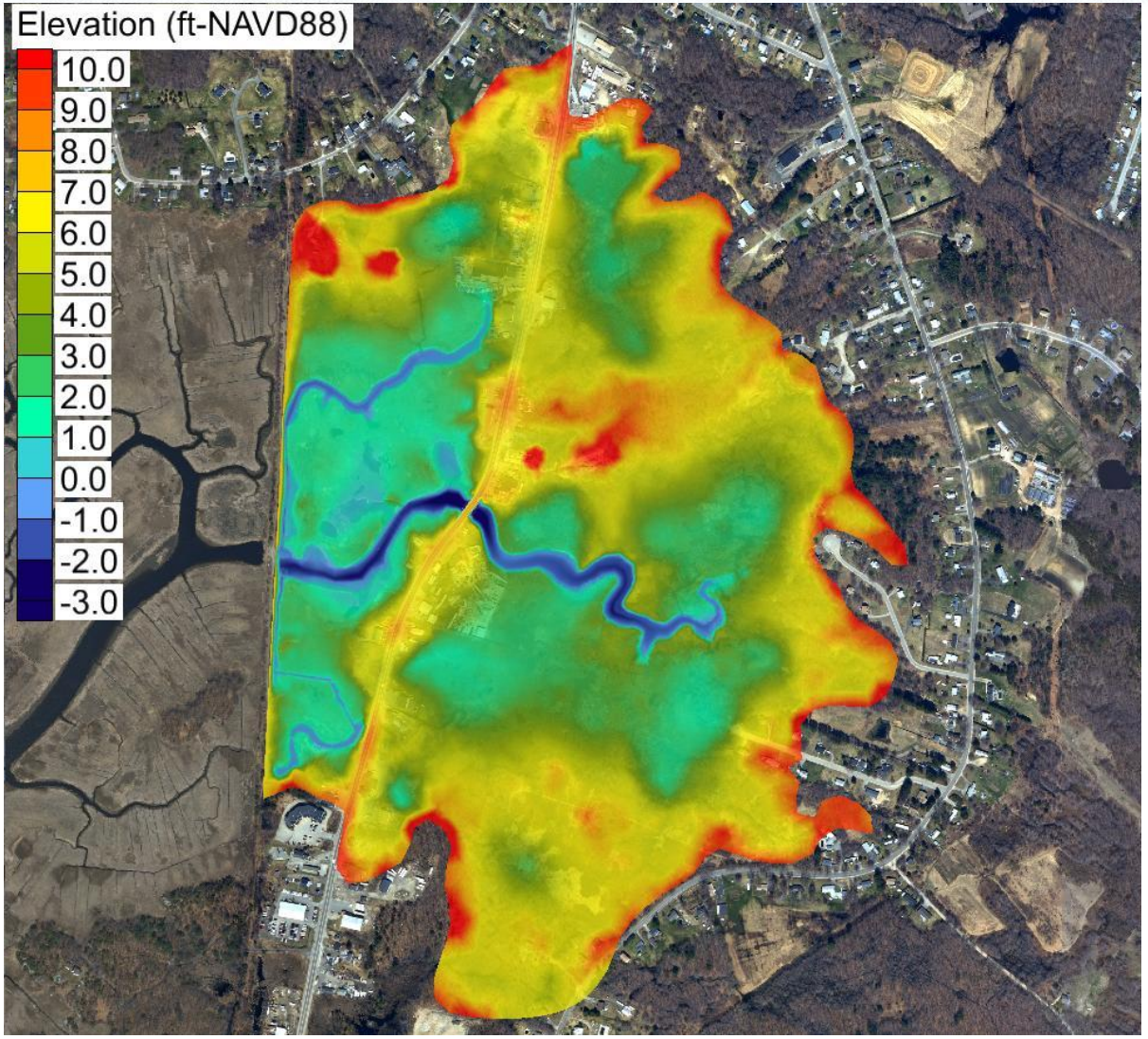


Existing Entrance

Tide Data and Rainfall



Topographic Data



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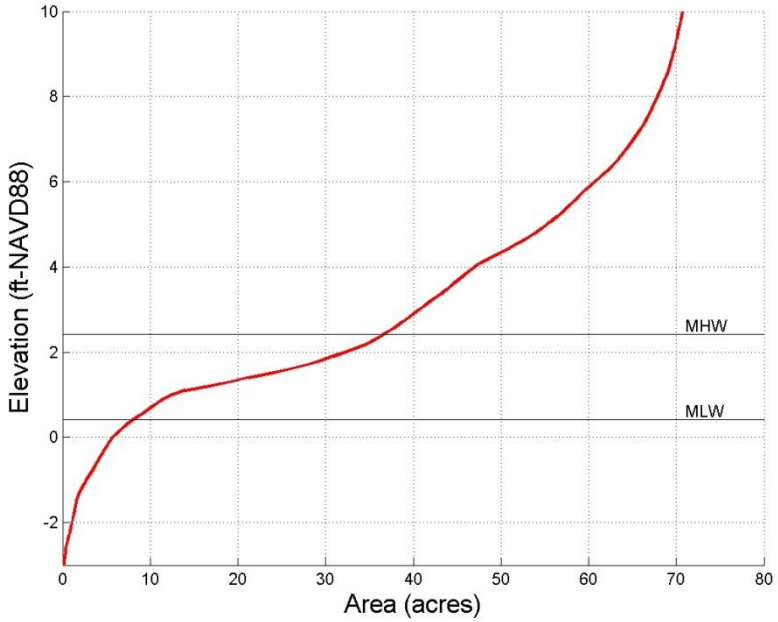
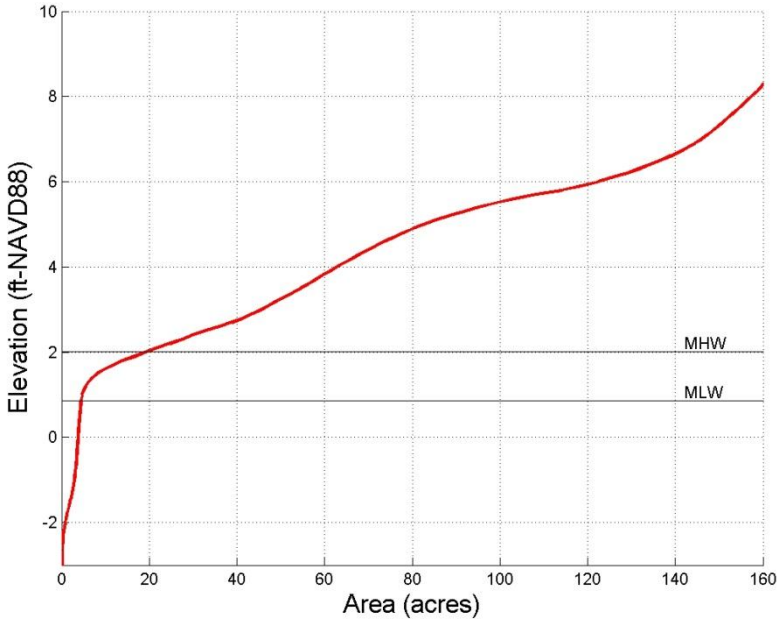
Basin Hypsometry

- Lower Basin



- Upper Basin



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Model Description

$$A(h_{marsh})\frac{dh_{marsh}}{dt} = Q_{culvert} + Q_{gw} + Q_{rain} + Q_{leak}$$

- Calculates the tidal response in a marsh connected to the ocean by a partially submerged round pipe or box culvert
- The assumptions are:
  - Sea level in the marsh is independent of position
  - Flow through the culvert is described by a standard quadratic head-loss relationship
  - Flow depth varies linearly along the length of the pipe or culvert if the pipe or culvert is only partially full

Model Approach

- Model Calibration
- Existing Conditions Simulations
  - Normal Tidal Conditions (Baseline)
  - Storm Scenarios (Rainfall and Storm Surge)
- Alternatives Assessment
  - Culvert replacement and Second Culvert
  - Sluice gate openings
  - Normal Tides and Storms

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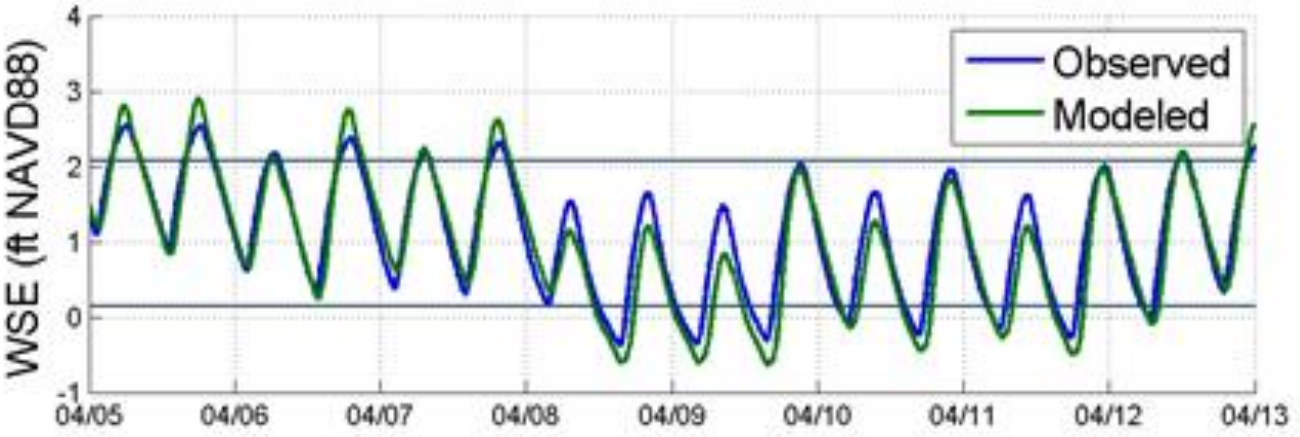
Model Calibration

Model Calibration (4/5/2007 – 4/13/2007)



Model Bias

- Downstream Basin Calibration = -0.11 feet (1.2 inches)

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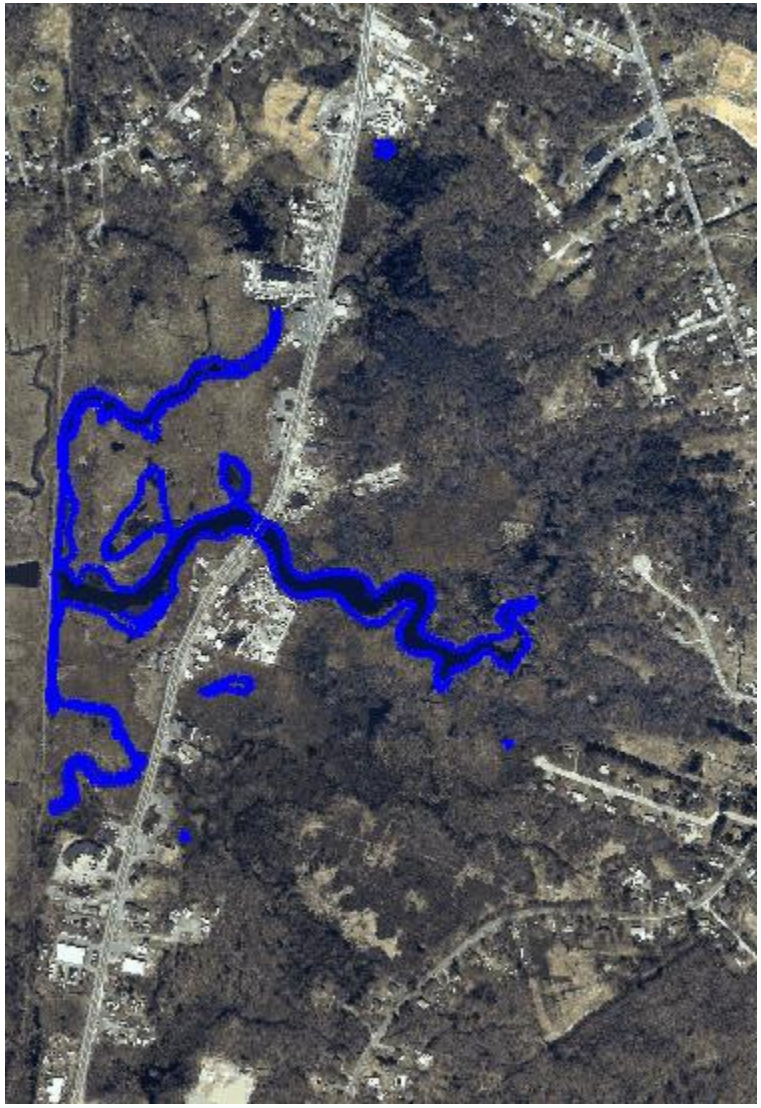
Existing Conditions



Alternative Evaluation

Combination
Sluice/Flap Tide Gate

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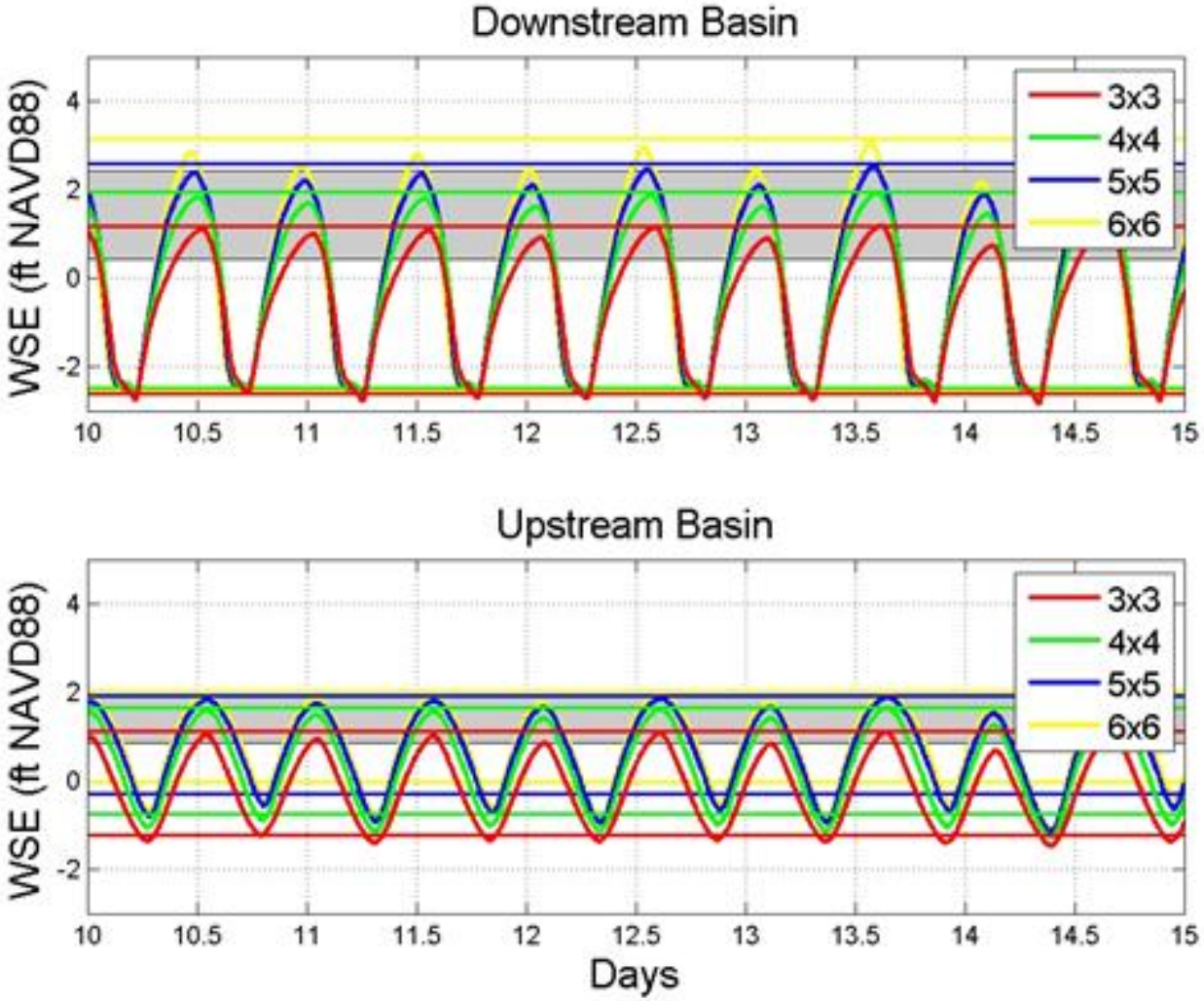
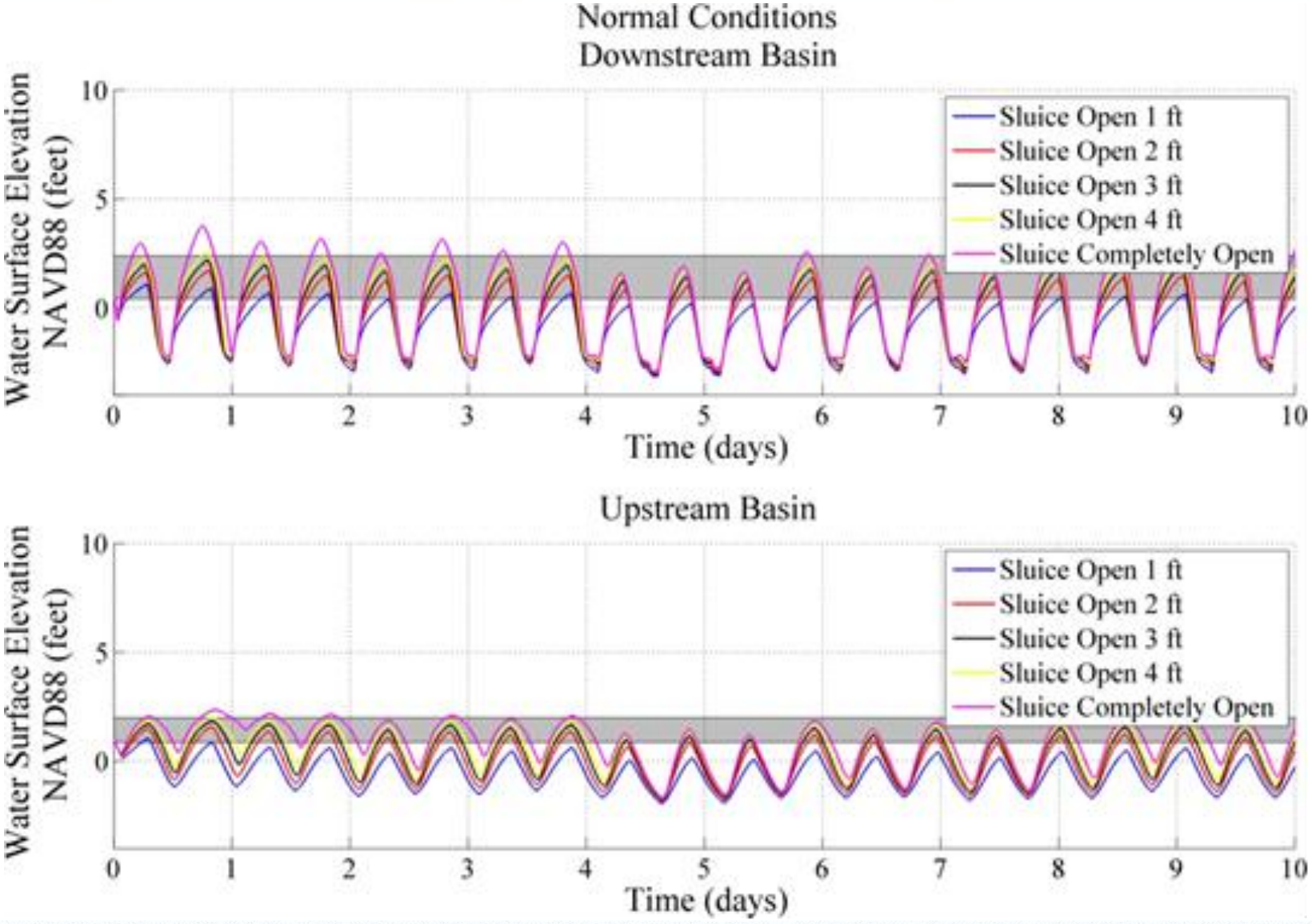
Alternative Evaluation

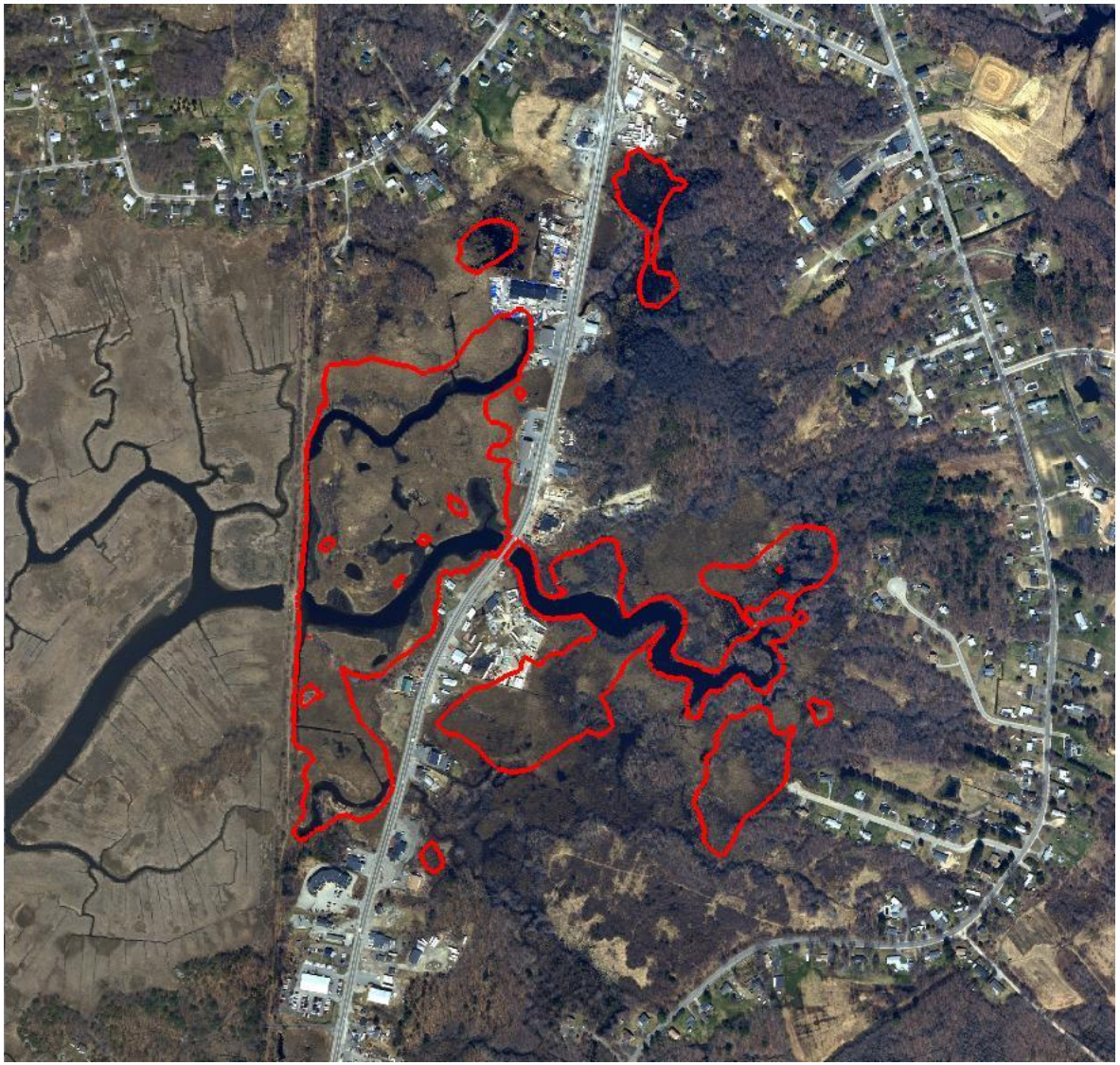


Alternative Evaluation



Topographic Data

2.3 feet NAVD88 contour



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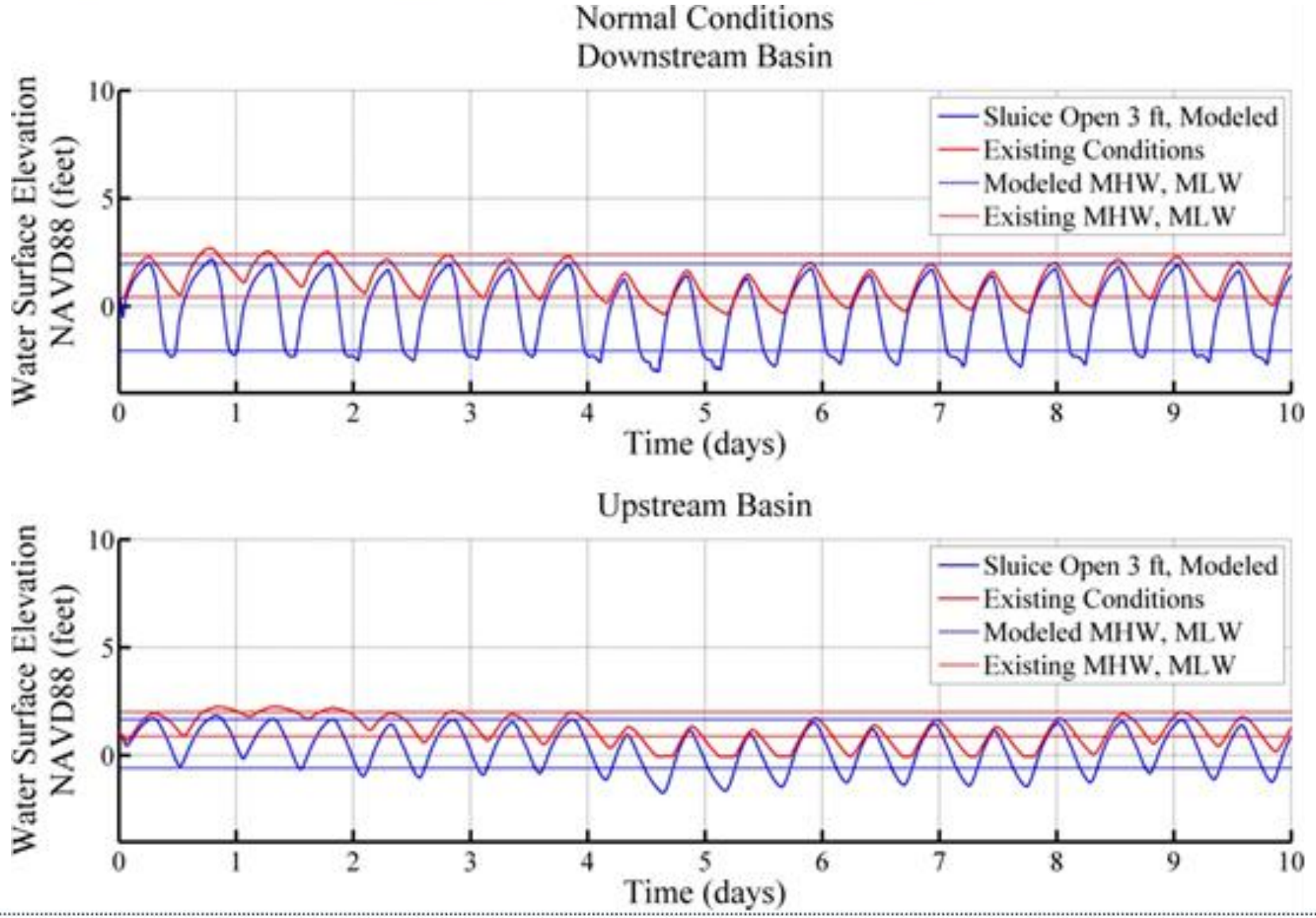
Alternative Evaluation



Proposed Opening

LOWER BASIN	Mean High Water (ft NAVD88)	Mean Low Water (ft NAVD88)	Tidal Range (ft)
Existing Conditions	2.4	0.4	2.0
Proposed Conditions (3 ft opening)	2.2	-2.2	4.4

UPPER BASIN	Mean High Water (ft NAVD88)	Mean Low Water (ft NAVD88)	Tidal Range (ft)
Existing Conditions	2.0	0.9	1.1
Proposed Conditions (3 ft opening)	1.6	-0.8	2.4

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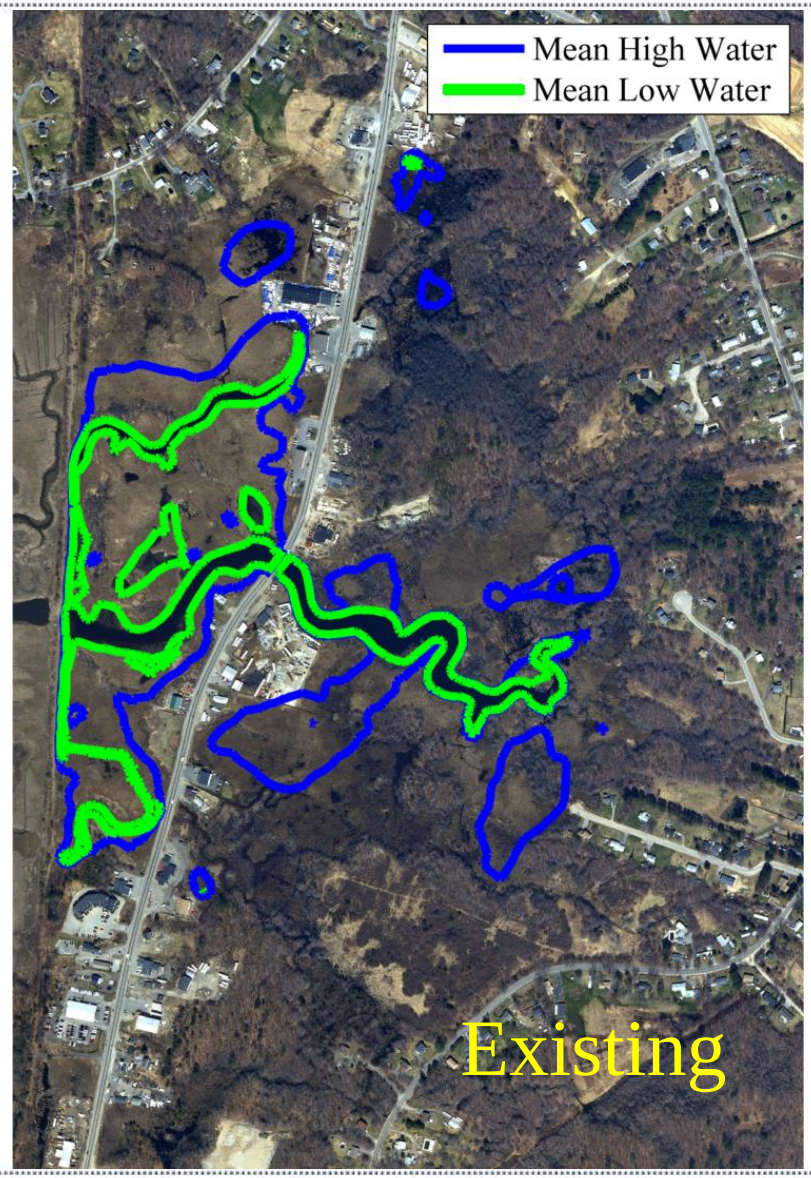
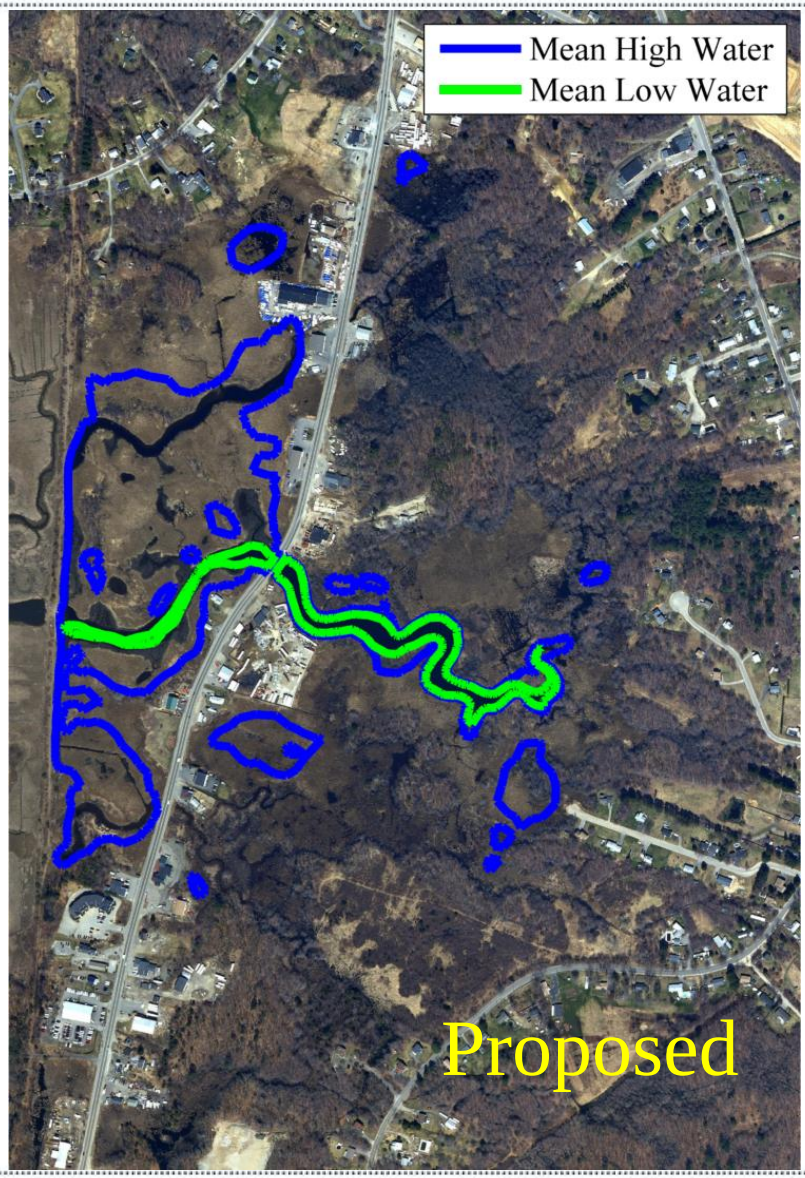
Proposed Opening





Proposed Opening

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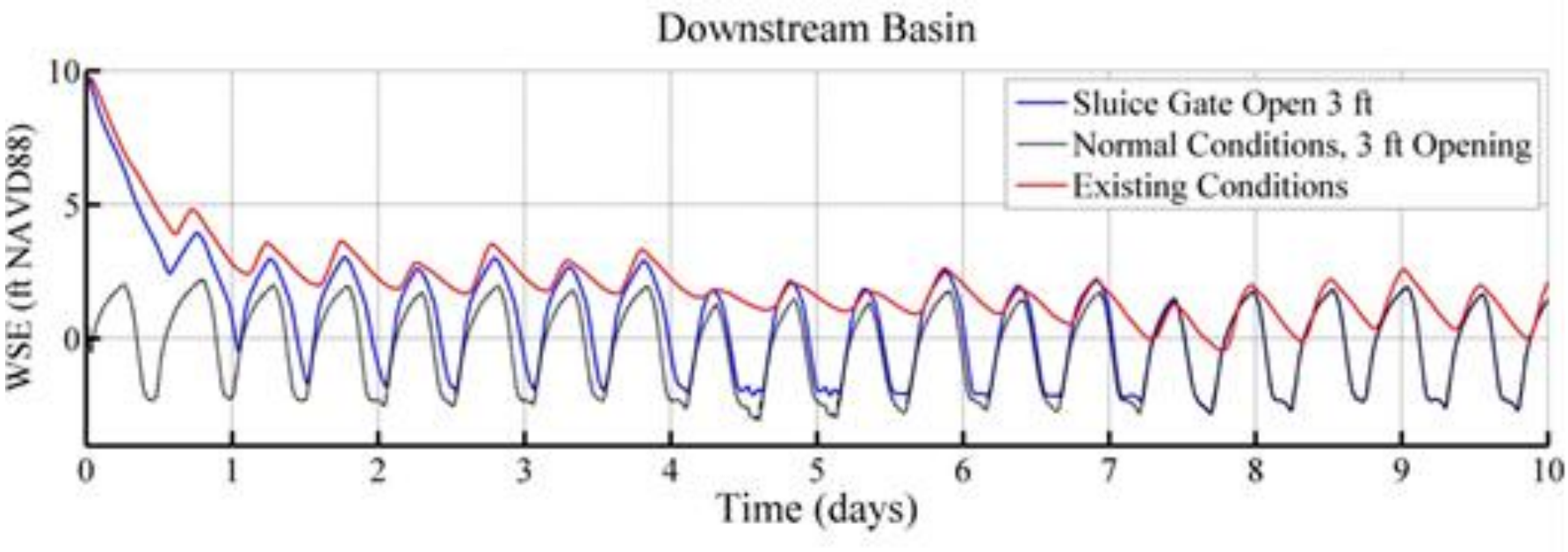
Storms – Rainfall Events



Existing Conditions > 4 days to return to normal
Proposed Conditions ~1 day to return to normal

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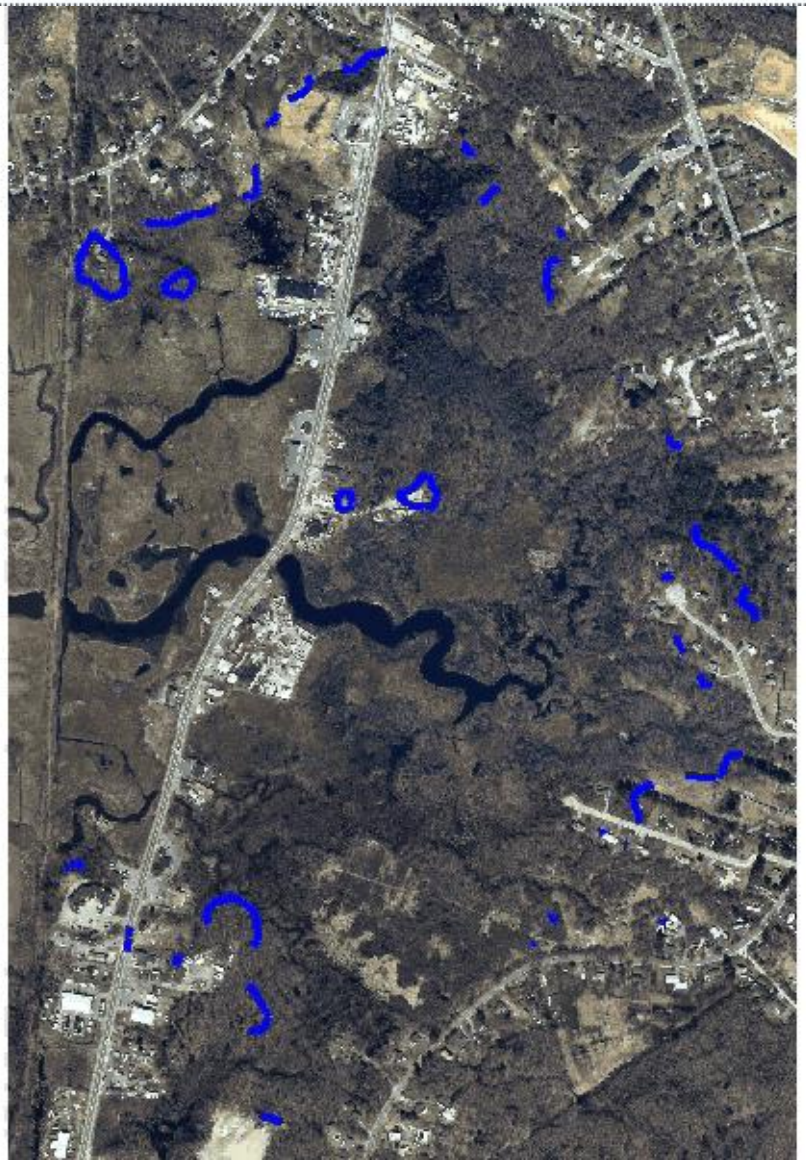
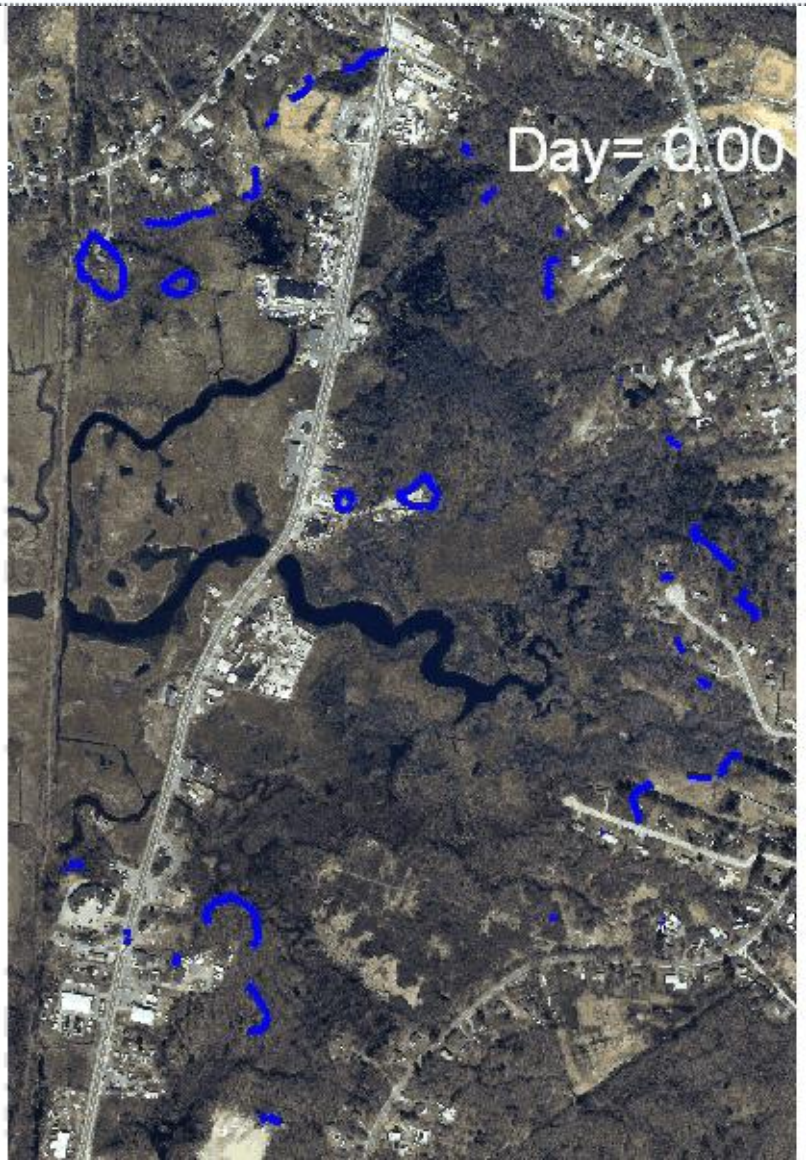
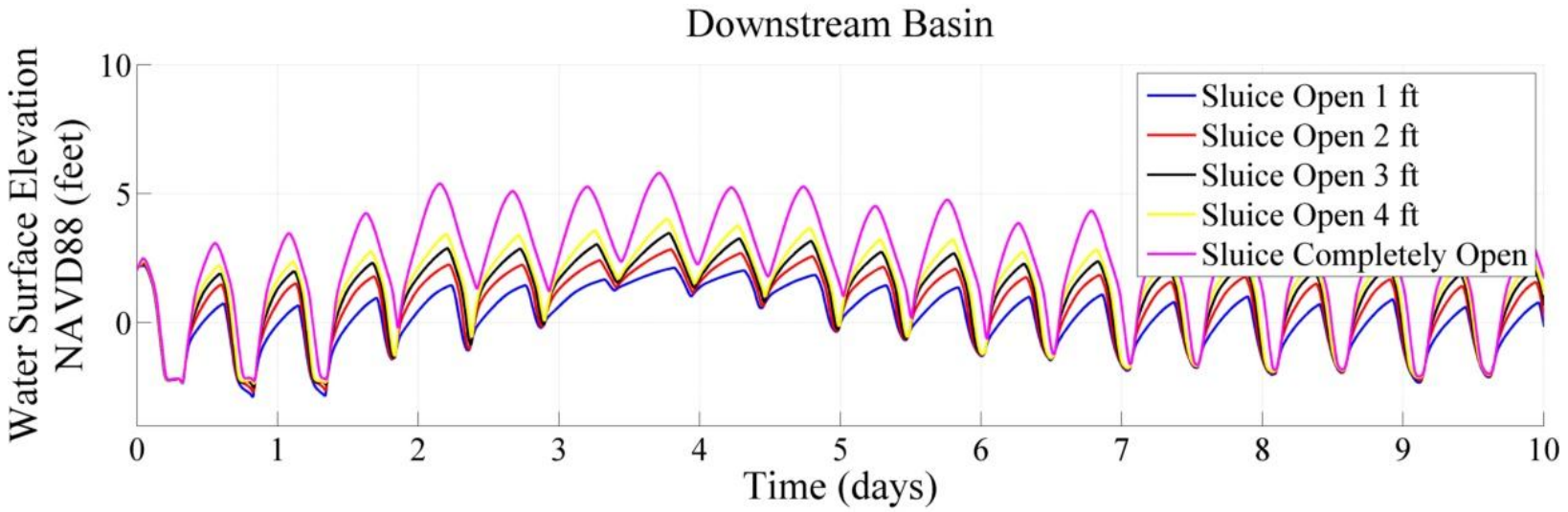
Storms – Rainfall Event





Storms – Storm Surge Events



Storm Surge in Merrimack River = 8.5 feet NAVD88

3 foot sluice opening = 3.5 feet NAVD88

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Conclusions

1. Recommend targeted 3 foot sluice opening at both culverts
   - Maximize ecological restoration
   - Minimize significant influence on upland infrastructure
   - Improve drainage ability during freshwater rain events
   - Mean sea level decrease
   - Improved tidal range and water quality

2. Adaptive management approach
   - Initially start with small sluice opening, monitor response, and increase opening to a maximum of 3 feet
   - If necessary, increased openings to alleviate freshwater discharge when necessary
   - Reduced opening during storm surge events

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